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SUMMARIZING A DECADE OF UNDERWATER STUDIES AT LOCH NESS

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ABSTRACT: In consort with other investigators and institutions, members of the Academy of Applied Science (AAS) have engaged in part-time studies of Scotland's Loch Ness during the past decade, with rewarding results in finding and tracking underwater life (including large animate objects and new small creatures), finding geological and man-made structures, developing new instrumentation, and in learning to blend scientists of various disciplines into a cooperative team for underwater exploration and analysis.

SONAR INVESTIGATIONS OF THE LARGE ANIMALS OF LOCH NESS

Since the digital sonar tracking of large underwater targets at Loch Ness in the late 1960's (Braithwaite and Tucker 1968), more extensive sonar exploration has been conducted by the Academy through the 1970's, some in consort with simultaneous attempts at underwater strobe photography. The Tucker equipment, like that of Robert Love of the Loch Ness Investigation Bureau in 1969, involved cathode-ray-tube presentations that made size resolution indication very difficult. The fact that what was detected was many, many times larger than the largest fish echoes, and that it was moving, was, however, incontrovertible. In the late 1970's, R. Parker and J. Buchanon reconfirmed large, moving mid-water targets.

In collaboration with Tim Dinsdale and Robert H. Rines, sonar designer and manufacturer Martin Klein, of Klein Associates, and the Academy brought higher definition chart-imaging side-scan sonar to the loch in the autumn of 1970 (Fig. 1) and, within a very short time, operating in both stationary and towing or moving modes, repeated the findings of Tucker and Love of moving underwater sonar targets of size many times that of the echoes returned from salmon in the loch (Klein, Rines, and Dinsdale 1972).

Since 1972, the Academy has brought to bear a variety of widely different sonar equipments and skilled operators, employing both fixed station and mobile modes of operation, and involving both low and high resolution systems, ranging from 20 kHz to 250 kHz in frequencies. Repeatedly, large moving mid-water objects were tracked, of echoing size ten to thirty or more times that of migrating sea salmon in the loch.

As mentioned earlier, some of the sonar contacts were made simultaneously with strobe photography, as described in the next section, which has provided the security of conclusion that real, sizable objects were in fact in the beam, because of the check afforded by the optical as well as acoustical

FIG. 1.—Robert H. Rines (left) with Martin Klein (center) and Tim Dinsdale deploying a Klein Associates side-scan sonar in Loch Ness.

sensing. Whether the poor quality of pictures is sufficiently definitive to allow an identification is really not germane to the scientific significance of verification of large moving objects; this simultaneous optical-sonar detection rather conclusively strengthens the reliability of the results.

Even more striking, however, is the repeatability in the hands of different researchers, at different times, with widely different sonar equipment, of the same dimensioned and shaped echo characteristics from extremely large moving targets in the loch—all quite distinct from boat, wake, and fish echoes.

Among the more striking repeated experiments are what is believed to be sonar echoing from the side or top of one of these large objects, with remarkable consistency of target width as indicated on the sonar chart recorders (see Table 1).

Not only has there been substantial repeatability of the top or side aspect of moving underwater objects, measured at 2–3 meters in target width (in the direction of the sonar beam), but a unique sonar echo characteristic has been obtained in what is believed to be a *head- or tail-on aspect* of the target—having successive echoing protuberances, numbering 5 to 6, and spaced about 1.5–2 meters apart (as from head structure, front body portion,

TABLE 1.

Year	Team	Type sonar	Sonar operations mode	Target range	Target width characteristics (in direction of sonar beam) indicated on chart	Simultaneous photographic indication of object
1972	AAS, Loch Ness Investigation Bureau, R. & C. Rines, T. Dinsdale, H. Arnold, R. Raynor, T. Willums, R. Needleman, August 9	Modified Raytheon DE725C (200 kHz)	Stationary (proof-positive of moving target)	45 meters	2–3 meters	Yes
1975	AAS, Rines, Dinsdale, June 20	Modified Raytheon DE725C (200 kHz)	Stationary	Approx. 10 meters from bottom sonar and from upper camera	Sonar trigger gate set for approx. 2 meters; triggered	Yes (on upper free-running camera; not on bottom sonar-triggered camera)
1976	Prof. H. E. Edgerton (MIT) and Charles W. Wyckoff (AAS),	EG & G Type 259 (105 kHz)				
	June 24		Stationary	175 meters	2–3 meters	No
	June 25		Stationary	155 meters	2–3 meters	No
	June 25		Stationary	195 meters	2–3 meters	No
	June 28		Stationary	130 meters	3 meters	No
	June 28		Stationary	205 meters	3 meters	No
	June 30		Stationary	145 meters	2+ meters	No
	July 1		Stationary	145 meters	2+ meters	No
	July 4		Stationary	155 meters	3 meters	No
1978	Tom Cummings, Larry Kozak of Klein Associates, with AAS, July 21	Klein Assoc. "Hydroscan" (side-scan) (100 kHz)	Towing	145 meters (in 215 meters of water)	2½–3 meters	No

TABLE 2.

Year	Team	Type sonar	Sonar operating mode	Target range	Target characteristic and width (in direction of beam) indicated on chart	Simultaneous photographic indication of object
1972	AAS, Loch Ness Investigation Bureau, Rines et al., August 9	Modified Raytheon DE725C (200 kHz)	Stationary	35 meters	5–6 parallel strands of average width and spacing 1½–2 meters, for overall width of about 10 meters (plotted over two 5-minute intervals and one 10-minute interval)	Yes
1976	Prof. H. E. Edgerton (MIT) and Charles W. Wyckoff (AAS)	EG & G Type 259 (105 kHz)	Stationary	175 meters	5–6 parallel strands of average width 1½–2 meters, spaced 1½–2 meters, for overall width of about 10 meters (plotted over 10-minute interval)	No

FIG. 2.—One of three subsurface "flipper" photographs obtained in August, 1972, during simultaneous and totally consistent sonar tracking of large unknown target, using an Edgerton elapsed-time strobe camera. Image enhancement was conducted by A. Gillespie, at the Jet Propulsion Laboratory, California Institute of Technology.

appendages, tail structure, etc.) to produce an overall target width of some 10 meters (see Table 2).

Also impressive is the similarity of performance of these targets in the sonar beam. In both the 1972 and the 1976 contacts, the target entered to a position where it stayed substantially in place and then receded at about the same speed of entry, with the departure accompanied by the streaming-away from the target of much smaller fish echoes.

Both in 1972 and 1976, furthermore, the target changed aspect, merging the 5–6 parallel trace signature into the 3-meter wide characteristic, apparently in changing from head- or tail-on aspect to side view.

In the summer of 1980, using an AAS sonar target trigger system (newly designed by D. Marshall of Megapulse, J. Lothrop of Polaroid, and C. Wyckoff of Brite-Lite, Inc.) for monitoring targets of 1.5–2 meters width in the direction of the beam, and automatically triggering a miniaturized 35 mm underwater camera designed for portability, as by dolphins, several triggerings were effected at 10 meters depth, but with inconclusive photographic results. This again verifies the consistent size of moving targets discussed before.

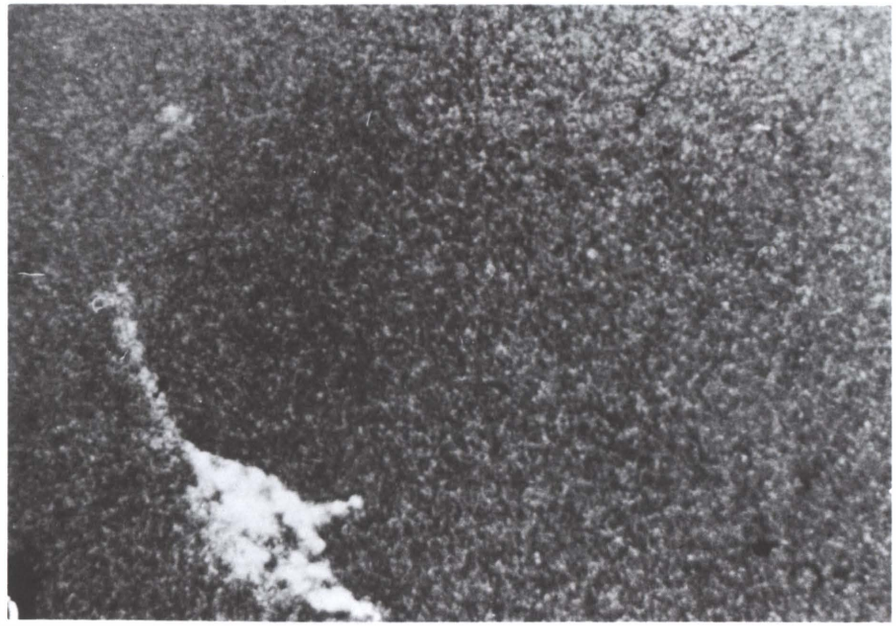

FIG. 3.—Subsurface "full body" photograph obtained in June, 1975. The upper part is interpreted to be a long neck and head extending from a bulky body.

VISUAL OBSERVATIONS AND SURFACE AND SUBSURFACE PHOTOGRAPHY

On at least three occasions during the 1970's, Academy investigators filmed, at a distance, moving protuberances in the lake that were setting up wake patterns in excess of several inches of amplitude—disturbances that did not resemble mergansers, swans, or other known lake birds, otters, seals, or the backs of even very large salmon.

The author and Carol Rines, in the company of the late former Wing Commander Basil Carey and Winifred Carey (and, unknown to them at the time, from a water-level perspective, local farmer Alex McLeod and his son Bill), were treated to the spectacle of about five minutes observation of a somewhat angular hump moving into Urquhart Bay, returning and submerging—a protuberance unanimously identified as an animate back almost 25 feet long (as contemporaneously compared with a nearby moored 52-foot vessel), and about 4–6 feet out of the water at the apex.

These episodes were repetitive of sightings and photographs of a myriad of other observers over the years (Whyte 1956).

Of more excitement to the Academy are the very rare subsurface photographs obtained with the Edgerton elapsed-time strobe cameras, some free-running and some accompanied by simultaneous sonar tracking or triggering as described above (Figs. 2, 3, and 4).

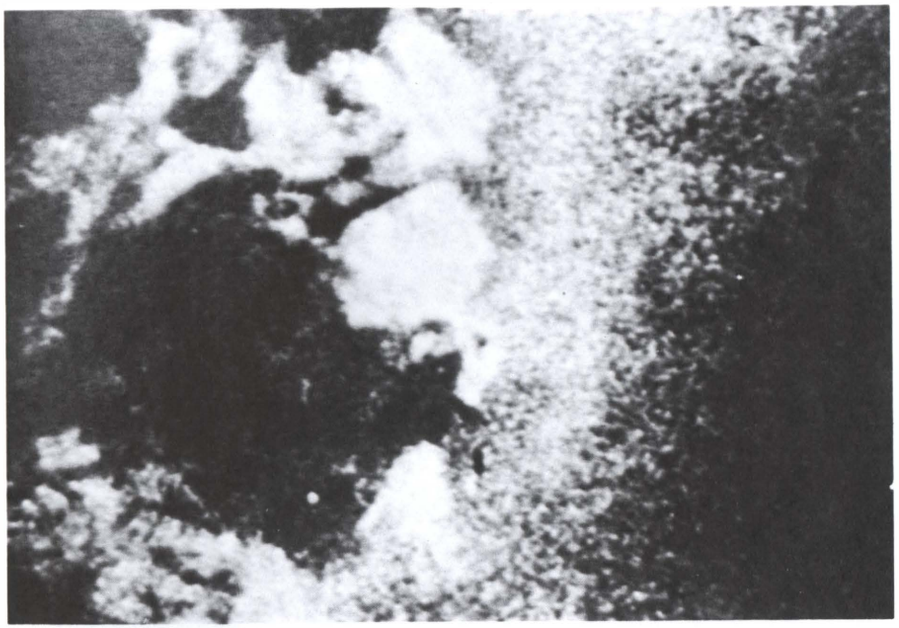

FIG. 4.—Subsurface photograph obtained in June, 1975, of what is interpreted to be the head of a large animal. Had the fast sonar-triggered, elapsed-time strobe technique now being used been in operation in 1975, there would have been several photographs of the "head" taken from different angles. This may have aided in identification.

OTHER STUDIES AND DISCOVERIES

We have reported elsewhere upon the serendipity of our side-scan sonar studies by Klein and Edgerton, leading to the finding of circular ring patterns on the bottom of the loch (Klein and Finkelstein 1976, Rines 1976), the shallower only of which have to date been partially explored by diving teams led by Professor Peter Milne of Glasgow University, Ian Morrison of the University of Edinburgh, Ivor Newby, and John Mills of Underwater Instrumentation Ltd. Some of these bear some resemblance to the surface structure of land burial cairns, and some to poured rock dumpings during the dredging of the Caledonian Canal in the 1820's.

The surprisingly flat bottom across the gorge that bounds Loch Ness has been plotted by different-frequencied bottom penetrating sonar, with some interesting indication of possible filling of an originally more steep cleavage, or of sound diffraction artifact effects (Klein and Finkelstein 1976).

The apparent sterility of the loch bottom away from the river mouths was verified by Academy members in cooperation with the crew of the Vickers submersible Pisces 8, in 1973. Despite the halide searchlights, we could see only 6–8 feet in front into the "tea" stained water (when our bottom runners

did not accidentally touch the bottom, setting up a dense cloud of exploding silt). We practiced using the mechanical arms of the submersible to recover an old rifle dumped into Urquhart Bay by the constabulary, signifying a useful tool if interesting skeletal remains or other artifacts are pin-pointed (despite Professor Morrison's recent experience that the chemistry of this type of Scottish lake is hostile to the preservation of bone). Incidentally, Carol Rines' color movies taken in saline Loch Linne from the Pisces 8 are of excellent quality. Would that Loch Ness were that clear!

Sound-listening experiments conducted in audible ranges by Academy board member I. S. Blonder have not yielded hopeful results. Sound attractant tests by Theo Brown of Australia, who has coordinated with Academy work over several years, assisted by Holly Arnold, have also not yet been successful. But more recent super-audible frequency bursts in the 40 to 85 kHz region have been recorded as received underwater by the Klein group (Rines and Curtis 1979) when tracking one of the large moving objects, and are to be tested as possible attractants in pending research. This may be fortuitous if future use of trained dolphin assistance is called upon in view of similar super-audible frequencies that Academy researchers have found to be emitted and received by dolphins.

Stimulated by the Carol Rines sighting, and photographs of moving "pipe" protuberances, the late Professor George Newton of MIT and the AAS conducted infra-red sensing tests of the loch surface, developing a 1–2 mile sensing capability. In the short time of the tests, he obtained no results bearing on the Loch Ness animal phenomenon.

Still unexplained is the bulbous type of scooting "animal" that we photographed underwater in 1973, but have never seen since.

The exciting discovery of indigenous Loch Ness bottom fish (not observed within depths less than about 75–100 feet), burrowing into the silt upon disturbance, and spending much of their time just hovering upon the bottom using tail and pectoral fins as stilts, introduced a new component to the food-chain supply in the loch. Sir Peter Scott, John Mills and other members of our team finally trapped one of these fish, characterized in the smaller sizes, at least, by red dots at either gill—later identified as a char, albeit Loch Ness species.

The above-mentioned miniaturized sonar-triggered elapsed-time camera equipment (TAD) developed by the Academy is one of our principal hopes for the continued experiments; either used in multiple numbers as buoys (dubbed "monster pots" by our New England members versed in the fishing for lobsters) to ensure more than partial pictures of animals and other objects, or carried by our research-minded dolphins, who have in our preliminary experiments shown their skill and zest for the quest.

The continued support and keen interest of our team and its friends in so many universities and private, governmental, and business institutions, who

contribute their expertise and resources to this intermittent and part-time continuing effort, are deeply appreciated; as is the long-time logistic and research assistance of Academy Counsel Robert Needleman, of our U.K. Coordinator, Gordon Sutherland MacKintosh, and of our Executive Vice-President, Howard S. Curtis.

Conclusions

Our researches in consort with others at Loch Ness have been rewarding, though frustrating in view of the limited time we have been able to devote to continued effort to date, the hostility of the environment, and of the problem itself.

Until adequate photographic results or higher definition sonar imaging is evolved, identification of the moving objects under the loch will not be possible.

Even were there not the growing wealth of surface and subsurface pictures and observations by reliable persons, the consistency of sonar tracking to date removes all doubt as to the continued presence—as we start the 1980's—of large, moving underwater animals in Loch Ness.

Recent interest at Loch Ness by Adrian Shine, J. Hogan and others in underwater television applications, which we found unrewarding for our purposes in our 1976 expedition with equipment of that vintage (though useful in the identification of the bottom char previously described), is another hopeful sign. Perhaps the animals already photographed so painfully and inadequately may electrify the world by posing on television.

The Academy team considers that the task for the 1980's is to help others who may be able to spend more time and with new techniques, and to put appropriate time and resources of our own into identification of the animals.

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